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1.12 Determination of the Spin-Spin Potential in the Optical Model from the Depolarization of Proton Elastic Scattering *)

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For the elastic scattering of nucleons from target nuclei with non-zero spin a spin-spin potential has been suggested [1] in addition to the well-known real, imaginary and spin-orbit potential terms. The spin-spin interaction is considered to be the sum of a spherical term

$$U_{SS}(r) = - V_{SS}\, f_o(r)\, \underset{\sim}{\sigma} \cdot \underline{I}$$

and a tensor term

$$U_{ST}(r) = - \frac{1}{2} V_{ST}\, f_T(r) \cdot \left[3(\underset{\sim}{\sigma}\, \hat{\underline{r}}) - (\underset{\sim}{\sigma} \cdot \underline{I}) \right]$$

where $\underset{\sim}{\sigma}$ and $\underline{I}$ denote particle and target spin, respectively, $\hat{\underline{r}}$ the relative vector and f_o and f_T the appropriate form factors. Theoretical estimates in the framework of different models [2-4] resulted in spherical spin-spin potentials much smaller than the usual spin orbit potential, whereas the tensor spin-spin potentials should be even smaller. The most sensitive observable for these spin-spin potentials is the depolarization $D(\Theta)$, which can be obtained from the analyzing power $A(\Theta)$ and the polarization of incoming and outcoming particles.

In this contribution we report on the measurement and a full analysis of $\sigma(\Theta)$, $A(\Theta)$ and $D(\Theta)$ for the elastic proton scattering on ^{27}Al (E_p=10.35 MeV and 11 MeV) and on ^{89}Y (E_p=11 MeV) in the angular range $40° \lesssim \Theta_{Lab} \lesssim 120°$. Differential cross section and analyzing power were measured in the usual way, whereas the polarization of the scattered protons was obtained in a special double scattering arrangement [5] consisting of a sliding seal chamber, a high acceptance QDQ magnetic spectrometer with Ω=20 msr and a high pressure ^4He-polarimeter (p=20 bar). For the elimination of instrumental asymmetries both the particle spin and the polarimeter are turned around 180° in a different time scale. The polarization of the incoming beam was measured on line in the first scattering chamber, where the known analyzing power of ^{27}Al and ^{89}Y, respectively, at backward angles was used.

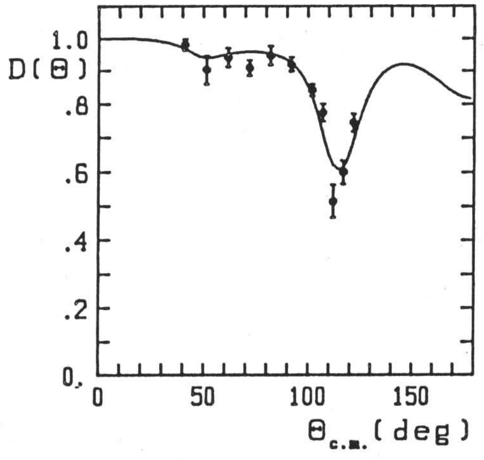

Fig.1 Measured depolarization for $^{27}Al(\vec{p},\vec{p}_o)$ at 11 MeV with a best fit curve (V_{SS}=1.1 MeV; V_{ST}=0.8 MeV).

As an example the measured depolarization is shown for $^{27}Al(\vec{p},\vec{p}_o)$ at E_p=11 MeV compared with a theoretical curve, where besides the spin-spin interaction compound nucleus effects [6] and the quadrupole spin-flip [7] is taken into account properly. The optical potential without spin-spin terms was obtained from an analysis of $\langle\sigma \cdot A\rangle$, which depends on the direct scattering only, and $\sigma^{DI} = \langle\sigma\rangle - \sigma^{CE}$, where the com-

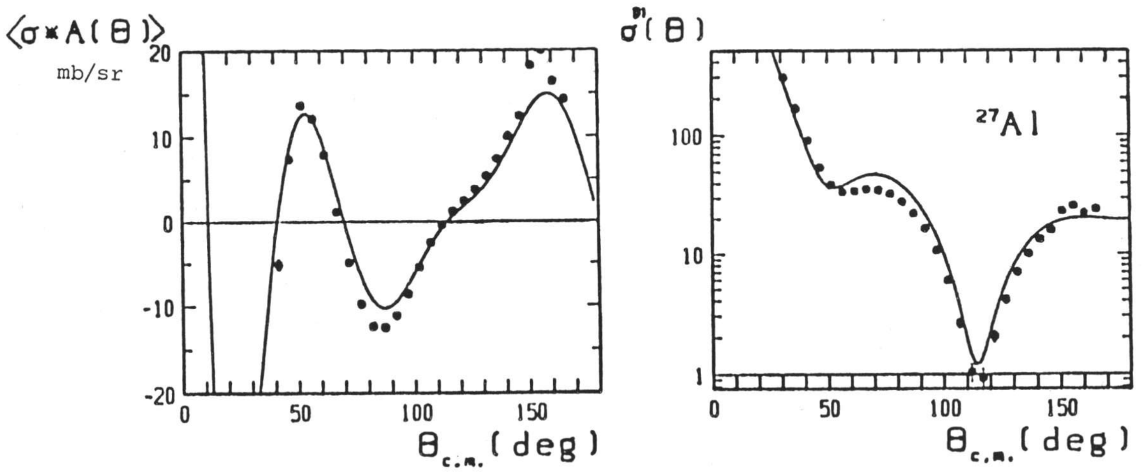

Fig.2 ⟨σ·A⟩ and σ^{DI} for ^{27}Al($\vec{p}$,p_o) at E_p=11 MeV compared with optical model curves.

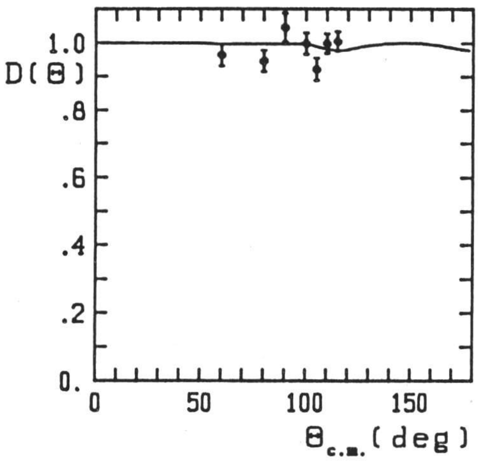

Fig.3 Measured depolarization for ^{89}Y($\vec{p}$,$\vec{p}_o$) at E_p=11 MeV compared with a theoretical curve (V_{SS}=V_{ST}=1 MeV).

pound-elastic contribution was calculated within a modified Hauser-Feshbach formalism (see fig.2). For ^{27}Al the results at both energies are consistent with $V_{SS}=(1\pm0.2)$ MeV and V_{ST} 1 MeV. For the I=1/2 nucleus ^{89}Y, where the effects in D(Θ) are much smaller, the depolarization data only yield an upper limit of 1 MeV for V_{SS} and V_{ST} (see fig.3).

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References

1) H. Feshbach: Nuclear Spectroscopy, ed. F. Ajzenberg-Selove (Academic Press, N.Y. 1960) part B, p. 1033
2) G.R. Satchler: Phys.Lett. 34B (1971) 37; Particles and Nuclei 1 (1971) 397
3) H.S. Sherif: IV. International Symposium on Polarization Phenomena in Nuclear Reactions, Zürich 1975, ed. W. Grüebler, V. König (Birkhäuser Verlag) p. 189
4) J. Dabrowsky and P. Haensel: Phys.Lett. 42B (1972) 163; Can.J.Phys. 52 (1974) 1768
5) W. Kretschmer, H. Löh, A. Rauscher, R. Schmitt and W. Schuster: contribution to this conference
6) W.J. Thompson Phys.Lett. 62B (1976) 245
7) J.S. Blair, M.P. Baker and H.S. Sherif: Phys.Lett. 60B (1975) 25